**3GPP TSG-RAN WG2 Meeting #109Bis-e R2-20xxxxx**

**E-meeting, April 2020**

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| *CR-Form-v11.4* |
| **CHANGE REQUEST** |
|  |
|  | **38.321** | **CR** |  **0708** | **rev** | **2** | **Current version:** | **16.0.0** |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | IAB MAC - rapporteur corrections and clarifications |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_IAB |  | ***Date:*** | 2020-04-23 |
|  |  |  |  |  |
| ***Category:*** |  **F** |  | ***Release:*** |  Rel-16 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)Rel-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
|  |  |
| ***Reason for change:*** | This CR implements agreements reached at RAN2#109Bis-e. |
|  |  |
| ***Summary of change:*** | (rev -)* This is rapporteur’s submission to the meeting
* Clarification to existing text on Guard symbols for IAB, to avoid misinterpretation
* Correction to table Table 5.20-1 (and alignment with RAN1 terminology)
* Several editorial clarifications

(rev 1)* Small editorial change to section 5.20.

(rev2)* Identifiers for all of the MAC CEs introduced by the IAB WI are changed – selected from set2 of the one-byte eLCID space.
* Pre-emptive BSR procedure is captured as a standalone Section (separate from Section 5.4.5 on “legacy” BSR), requiring a new section, and the removal of Pre-emptive BSR from the “legacy” BSR section.
* A short section on procedural aspects for Timing offset adjustment for IAB is introduced.
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| ***Consequences if not approved:*** | Latest agreed functionality would be missing. Several factual errors would (such as those in Table 5.20-1) would remain. |
|  |  |
| ***Clauses affected:*** | 5.4.5 Buffer Status Reporting5.4.x Pre-emptive Buffer Status Reporting5.18.x Timing offset adjustment for IAB5.20 Guard symbols for IAB6.1.3.1 Buffer Status Report MAC CEs6.2.1 MAC subheader for DL-SCH and UL-SCH |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |

|  |  |
| --- | --- |
| ***This CR's revision history:*** | Please see ‘Summary of change’ field. |

FIRST CHANGE

5.4.5 Buffer Status Reporting

The Buffer Status reporting (BSR) procedure is used to provide the serving gNB with information about UL data volume in the MAC entity.

RRC configures the following parameters to control the BSR:

- *periodicBSR-Timer*;

- *retxBSR-Timer*;

- *logicalChannelSR-DelayTimerApplied*;

- *logicalChannelSR-DelayTimer*;

- *logicalChannelSR-Mask*;

- *logicalChannelGroup*.

Each logical channel may be allocated to an LCG using the *logicalChannelGroup*. The maximum number of LCGs is eight.

The MAC entity determines the amount of UL data available for a logical channel according to the data volume calculation procedure in TSs 38.322 [3] and 38.323 [4].

A BSR shall be triggered if any of the following events occur:

- UL data, for a logical channel which belongs to an LCG, becomes available to the MAC entity; and either

- this UL data belongs to a logical channel with higher priority than the priority of any logical channel containing available UL data which belong to any LCG; or

- none of the logical channels which belong to an LCG contains any available UL data.

 in which case the BSR is referred below to as 'Regular BSR';

- UL resources are allocated and number of padding bits is equal to or larger than the size of the Buffer Status Report MAC CE plus its subheader, in which case the BSR is referred below to as 'Padding BSR';

- *retxBSR-Timer* expires, and at least one of the logical channels which belong to an LCG contains UL data, in which case the BSR is referred below to as 'Regular BSR';

- *periodicBSR-Timer* expires, in which case the BSR is referred below to as 'Periodic BSR'.

NOTE 1: When Regular BSR triggering events occur for multiple logical channels simultaneously, each logical channel triggers one separate Regular BSR.

For Regular BSR, the MAC entity shall:

1> if the BSR is triggered for a logical channel for which *logicalChannelSR-DelayTimerApplied* with value *true* is configured by upper layers:

2> start or restart the *logicalChannelSR-DelayTimer*.

1> else:

2> if running, stop the *logicalChannelSR-DelayTimer*.

For Regular and Periodic BSR, the MAC entity shall:

1> if more than one LCG has data available for transmission when the MAC PDU containing the BSR is to be built:

2> report Long BSR for all LCGs which have data available for transmission.

1> else:

2> report Short BSR.

For Padding BSR, the MAC entity shall:

1> if the number of padding bits is equal to or larger than the size of the Short BSR plus its subheader but smaller than the size of the Long BSR plus its subheader:

2> if more than one LCG has data available for transmission when the BSR is to be built:

3> if the number of padding bits is equal to the size of the Short BSR plus its subheader:

4> report Short Truncated BSR of the LCG with the highest priority logical channel with data available for transmission.

3> else:

4> report Long Truncated BSR of the LCG(s) with the logical channels having data available for transmission following a decreasing order of the highest priority logical channel (with or without data available for transmission) in each of these LCG(s), and in case of equal priority, in increasing order of LCGID.

2> else:

3> report Short BSR.

1> else if the number of padding bits is equal to or larger than the size of the Long BSR plus its subheader:

2> report Long BSR for all LCGs which have data available for transmission.

For BSR triggered by *retxBSR-Timer* expiry, the MAC entity considers that the logical channel that triggered the BSR is the highest priority logical channel that has data available for transmission at the time the BSR is triggered.

The MAC entity shall:

1> if the Buffer Status reporting procedure determines that at least one BSR has been triggered and not cancelled:

2> if UL-SCH resources are available for a new transmission and the UL-SCH resources can accommodate the BSR MAC CE plus its subheader as a result of logical channel prioritization:

3> instruct the Multiplexing and Assembly procedure to generate the BSR MAC CE(s);

3> start or restart *periodicBSR-Timer* except when all the generated BSRs are long or short Truncated BSRs;

3> start or restart *retxBSR-Timer*.

2> if a Regular BSR has been triggered and *logicalChannelSR-DelayTimer* is not running:

3> if there is no UL-SCH resource available for a new transmission; or

3> if the MAC entity is configured with configured uplink grant(s) and the Regular BSR was triggered for a logical channel for which *logicalChannelSR-Mask* is set to *false*; or

3> if the UL-SCH resources available for a new transmission do not meet the LCP mapping restrictions (see clause 5.4.3.1) configured for the logical channel that triggered the BSR:

4> trigger a Scheduling Request.

NOTE 2: UL-SCH resources are considered available if the MAC entity has an active configuration for either type of configured uplink grants, or if the MAC entity has received a dynamic uplink grant, or if both of these conditions are met. If the MAC entity has determined at a given point in time that UL-SCH resources are available, this need not imply that UL-SCH resources are available for use at that point in time.

For the case when Pre-emptive BSR is being sent (as specified in clause 5.4.x), a MAC PDU may contain one BSR MAC CE for Pre-emptive BSR, and one BSR MAC CE for BSR other than Pre-emptive BSR. A MAC PDU not containing a BSR MAC CE for Pre-emptive BSR shall contain at most one BSR MAC CE, even when multiple events have triggered a BSR. The Regular BSR and the Periodic BSR shall have precedence over the padding BSR.

The MAC entity shall restart *retxBSR-Timer* upon reception of a grant for transmission of new data on any UL-SCH.

All triggered BSRs may be cancelled when the UL grant(s) can accommodate all pending data available for transmission but is not sufficient to additionally accommodate the BSR MAC CE plus its subheader. All BSRs triggered prior to MAC PDU assembly shall be cancelled when a MAC PDU is transmitted, regardless of LBT failure indication from lower layers, and this PDU includes a Long or Short BSR MAC CE which contains buffer status up to (and including) the last event that triggered a BSR prior to the MAC PDU assembly.

NOTE 3: MAC PDU assembly can happen at any point in time between uplink grant reception and actual transmission of the corresponding MAC PDU. BSR and SR can be triggered after the assembly of a MAC PDU which contains a BSR MAC CE, but before the transmission of this MAC PDU. In addition, BSR and SR can be triggered during MAC PDU assembly.

NOTE 4: If a HARQ process is configured with *cg-RetransmissionTimer* and if the BSR is already included in a MAC PDU for transmission by this HARQ process, but not yet transmitted by lower layers, it is up to UE implementation how to handle the BSR content.

NEXT CHANGE

5.4.x Pre-emptive Buffer Status Reporting

The Pre-emptive Buffer Status reporting (Pre-emptive BSR) procedure is used by an IAB-MT to provide its parent IAB-DU with the information about the amount of the data expected to arrive at the MT of the IAB node from its child node(s) and or UE(s) connected to it.

If configured, Pre-emptive BSR may be triggered for the specific case of an IAB-MT if any of the following events occur:

- UL grant is provided to child IAB node or UE;

- BSR is received from child IAB node or UE.

The MAC entity shall:

1> if the Buffer Status reporting procedure determines that at least one Pre-emptive BSR has been triggered and not cancelled:

2> if UL-SCH resources are available for a new transmission and the UL-SCH resources can accommodate the Pre-emptive BSR MAC CE plus its subheader as a result of logical channel prioritization:

3> instruct the Multiplexing and Assembly procedure to generate the Pre-emptive BSR MAC CE.

2> else:

3> trigger a Scheduling Request.

A Pre-emptive BSR shall be cancelled when a MAC PDU is transmitted and this PDU includes the corresponding Pre-emptive BSR MAC CE.

NOTE: Pre-emptive BSR may be used for the case of dual-connected IAB node. It is up to network implementation to work out the associated MAC entity or entities, and the associated expected amount of data. For the case of dual-connected IAB node, there may be ambiguity in Pre-emptive BSR calculations and interpretation by the receiving nodes in case where BH RLC channels mapped to different egress Cell Groups are not mapped to different ingress LCGs.

NEXT CHANGE

### 5.18.x Timing offset adjustment for IAB

For IAB operation, in order to achieve time-domain synchronization across multiple backhaul hops, a timing adjustment Tdelta may be provided to an IAB-MT from its parent IAB-DU. This parameter is applicable only to IAB nodes. The Timing Delta MAC CE carries Tdelta, mapped to an index value *Tdelta*.

Upon reception of a Timing Delta MAC CE the MAC entity shall:

1. indicate to lower layers the index value of *Tdelta*.

NEXT CHANGE

5.20 Guard symbols for IAB

For IAB operation, the MAC entity on the IAB-DU or IAB-donor DU should reserve a sufficient number of symbols at the beginning and/or the end of slots where the child IAB-node switches operation from its IAB-DU to its IAB-MT function and operation from its IAB-MT to its IAB-DU function. The MAC entity on the IAB-DU or IAB-donor DU informs the child node about the number of guard symbols it provides via the Provided Guard Symbol MAC CE. The IAB-MT on the child node can inform the parent IAB-DU or IAB-donor DU about the number of guard symbols desired via the Desired Guard Symbol MAC CE.

Upon reception of a Provided Guard Symbol MAC CE the MAC entity shall:

- indicate to lower layers the number of provided guard symbols and the SCS configuration.

The MAC entity may:

1> if a Desired Guard Symbol query has not been triggered:

2> trigger a Desired Guard Symbol query.

If the MAC entity has UL resources allocated for new transmission the MAC entity shall:

1> for each Desired Guard Symbol query that has been triggered and not cancelled:

2> if the allocated UL resources can accommodate a Desired Guard Symbol MAC CE plus its subheader as a result of LCP as defined in clause 5.4.3.1:

3> instruct the Multiplexing and Assembly procedure to generate the Desired Guard Symbol MAC CE;

3> cancel this Desired Guard Symbol query.

A separate value for the number of guard symbols is specified for each of the following eight switching scenarios (see Table 5.20-1).

**Table 5.20-1: Switching scenarios and relevant guard symbols**

|  |  |
| --- | --- |
| **Switching scenario** | **Field for number of guard symbols in MAC CE** |
| IAB-MT operation to IAB-DU operation | MT Rx to DU Tx | NmbGS1 |
| MT Rx to DU Rx | NmbGS2 |
| MT Tx to DU Tx | NmbGS3 |
| MT Tx to DU Rx | NmbGS4 |
| IAB-DU operation to IAB-MT operation | DU Rx to MT Tx | NmbGS5 |
| DU Rx to MT Rx | NmbGS6 |
| DU Tx to MT Tx | NmbGS7 |
| DU Tx to MT Rx | NmbGS8 |

NEXT CHANGE

6.1.3.1 Buffer Status Report MAC CEs

Buffer Status Report (BSR) MAC CEs consist of either:

- Short BSR format (fixed size); or

- Long BSR format (variable size); or

- Short Truncated BSR format (fixed size); or

- Long Truncated BSR format (variable size); or

- Pre-emptive BSR format (variable size).

The BSR formats are identified by MAC subheaders with LCIDs as specified in Table 6.2.1-2.

The fields in the BSR MAC CE are defined as follows:

- LCG ID: The Logical Channel Group ID field identifies the group of logical channel(s) whose buffer status is being reported. The length of the field is 3 bits;

- LCGi: For the Long BSR format, this field indicates the presence of the Buffer Size field for the logical channel group i. The LCGi field set to 1 indicates that the Buffer Size field for the logical channel group i is reported. The LCGi field set to 0 indicates that the Buffer Size field for the logical channel group i is not reported. For the Long Truncated BSR format, this field indicates whether logical channel group i has data available. The LCGi field set to 1 indicates that logical channel group i has data available. The LCGi field set to 0 indicates that logical channel group i does not have data available;

- Buffer Size: The Buffer Size field identifies the total amount of data available according to the data volume calculation procedure in TSs 38.322 [3] and 38.323 [4] across all logical channels of a logical channel group after the MAC PDU has been built (i.e. after the logical channel prioritization procedure, which may result the value of the Buffer Size field to zero). The amount of data is indicated in number of bytes. The size of the RLC and MAC headers are not considered in the buffer size computation. The length of this field for the Short BSR format and the Short Truncated BSR format is 5 bits. The length of this field for the Long BSR format and the Long Truncated BSR format is 8 bits. The values for the 5-bit and 8-bit Buffer Size fields are shown in Tables 6.1.3.1-1 and 6.1.3.1-2, respectively. For the Long BSR format and the Long Truncated BSR format, the Buffer Size fields are included in ascending order based on the LCGi. For the Long Truncated BSR format the number of Buffer Size fields included is maximised, while not exceeding the number of padding bits. For the Pre-emptive BSR format, the Buffer Size field identifies the total amount of the data expected to arrive at the IAB-MT of the node where the Pre-emptive BSR is triggered and does not include the volume of data currently available in the IAB-MT. Pre-emptive BSR format is identical to the Long BSR format.

NOTE 1: For the Pre-emptive BSR, if configured, the LCGs to be reported, the expected data volume calculation, the exact time to report Pre-emptive BSR and the associated LCH are left to implementation.

NOTE 2: The mapping of LCGs between the ingress and egress links of an IAB node for purposes of determining expected change in occupancy of IAB-MT buffers (to be reported as Pre-emptive BSR) is left to implementation.

NOTE 3: The number of the Buffer Size fields in the Long BSR and Long Truncated BSR format can be zero.

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**Figure 6.1.3.1-1: Short BSR and Short Truncated BSR MAC CE**

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**Figure 6.1.3.1-2: Long BSR, Long Truncated BSR, and Pre-emptive BSR** **MAC CE**

NEXT CHANGE

6.2 Formats and parameters

6.2.1 MAC subheader for DL-SCH and UL-SCH

The MAC subheader consists of the following fields:

- LCID: The Logical Channel ID field identifies the logical channel instance of the corresponding MAC SDU or the type of the corresponding MAC CE or padding as described in Tables 6.2.1-1 and 6.2.1-2 for the DL-SCH and UL-SCH respectively. There is one LCID field per MAC subheader. The LCID field size is 6 bits. If the LCID field is set to 34, one additional octet is present in the MAC subheader containing the eLCID field and follow the octet containing LCID field. If the LCID field is set to 33, two additional octets are present in the MAC subheader containing the eLCID field and these two additional octets follow the octet containing LCID field;

- eLCID: The extended Logical Channel ID field identifies the logical channel instance of the corresponding MAC SDU as described in tables 6.2.1-1a, 6.2.1-1b, 6.2.1-2a and 6.2.1-2b for the DL-SCH and UL-SCH respectively. The size of the eLCID field is either 8 bits or 16 bits.

NOTE 1: The extended Logical Channel ID space using two-octet eLCID and the relevant MAC subheader format is used, only when configured, on the NR backhaul links between IAB nodes or between IAB node and IAB Donor.

- L: The Length field indicates the length of the corresponding MAC SDU or variable-sized MAC CE in bytes. There is one L field per MAC subheader except for subheaders corresponding to fixed-sized MAC CEs, padding, and MAC SDUs containing UL CCCH. The size of the L field is indicated by the F field;

- F: The Format field indicates the size of the Length field. There is one F field per MAC subheader except for subheaders corresponding to fixed-sized MAC CEs, padding, and MAC SDUs containing UL CCCH. The size of the F field is 1 bit. The value 0 indicates 8 bits of the Length field. The value 1 indicates 16 bits of the Length field;

- R: Reserved bit, set to 0.

The MAC subheader is octet aligned.

**Table 6.2.1-1 Values of LCID for DL-SCH**

|  |  |
| --- | --- |
| **Codepoint/Index** | **LCID values** |
| 0 | CCCH |
| 1–32 | Identity of the logical channel |
| 33 | Extended logical channel ID field (two-octet eLCID field) |
| 34 | Extended logical channel ID field (one–octet eLCID field) |
| 35 | Reserved |
| 36 | SP Positioning SRS Activation/Deactivation |
| 37 | Duplication RLC Activation/Deactivation |
| 38 | Absolute Timing Advance Command |
| 39 | CC list-based SRS Activation/Deactivation |
| 40 | PUSCH Pathloss Reference RS Activation/Deactivation |
| 41 | SRS Pathloss Reference RS Activation/Deactivation |
| 42 | AP SRS spatial relation Indication |
| 43 | Enhanced PUCCH spatial relation Activation/Deactivation |
| 44 | Enhanced TCI States Activation/Deactivation for UE-specific PDSCH |
| 45–46 | Reserved |
|  |  |
| 47 | Recommended bit rate |
| 48 | SP ZP CSI-RS Resource Set Activation/Deactivation |
| 49 | PUCCH spatial relation Activation/Deactivation |
| 50 | SP SRS Activation/Deactivation  |
| 51 | SP CSI reporting on PUCCH Activation/Deactivation |
| 52 | TCI State Indication for UE-specific PDCCH |
| 53 | TCI States Activation/Deactivation for UE-specific PDSCH |
| 54 | Aperiodic CSI Trigger State Subselection |
| 55 | SP CSI-RS/CSI-IM Resource Set Activation/Deactivation |
| 56 | Duplication Activation/Deactivation |
| 57 | SCell Activation/Deactivation (four octets) |
| 58 | SCell Activation/Deactivation (one octet) |
| 59 | Long DRX Command |
| 60 | DRX Command |
| 61 | Timing Advance Command |
| 62 | UE Contention Resolution Identity |
| 63 | Padding |

**Table 6.2.1-1a Values of two-octet eLCID for DL-SCH**

|  |  |
| --- | --- |
| **Index** | **LCID values** |
| 320 to (216 + 191) | Identity of the logical channel |
| (216 + 192) to (216 + 319) | Reserved |

**Table 6.2.1-1b Values of one-octet eLCID for DL-SCH**

|  |  |  |
| --- | --- | --- |
| **Codepoint** | **Index** | **LCID values** |
| 0 to 253 | 64 to 317 | reserved |
| 254 | 318 | Number of Provided Guard Symbols |
| 255 | 319 | Timing Delta |

**Table 6.2.1-2 Values of LCID for UL-SCH**

|  |  |
| --- | --- |
| **Index** | **LCID values** |
| 0 | CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331 [5]) |
| 1–32 | Identity of the logical channel |
| 33 | Extended logical channel ID field (two–octet eLCID field) |
| 34 | Extended logical channel ID field (one–octet eLCID field) |
| 35–39 | Reserved |
| 40 | Sidelink Configured Grant Confirmation |
| 41 | Truncated Sidelink BSR |
| 42 | Sidelink BSR |
| 43 | Multiple Entry Configured Grant Confirmation |
| 44 | LBT failure (four octets) |
| 45 | LBT failure (one octet) |
| 46 | SCell BFR (four octets Ci) |
| 47 | SCell BFR (one octet Ci) |
| 48 | Truncated SCell BFR (four octets Ci) |
| 49 | Truncated SCell BFR (one octet Ci) |
| 50–51 | Reserved |
|  |  |
| 52 | CCCH of size 48 bits (referred to as "CCCH" in TS 38.331 [5]) |
| 53 | Recommended bit rate query |
| 54 | Multiple Entry PHR (four octets Ci) |
| 55 | Configured Grant Confirmation |
| 56 | Multiple Entry PHR (one octet Ci) |
| 57 | Single Entry PHR |
| 58 | C-RNTI |
| 59 | Short Truncated BSR |
| 60 | Long Truncated BSR |
| 61 | Short BSR |
| 62 | Long BSR |
| 63 | Padding |

**Table 6.2.1-2a Values of two-octet eLCID for UL-SCH**

|  |  |
| --- | --- |
| **Codepoint/IIndex** | **LCID values** |
| 320 to (216 + 191) | Identity of the logical channel |
| (216 + 192) to (216 + 319) | Reserved |

**Table 6.2.1-2b Values of one-octet eLCID for UL-SCH**

|  |  |  |
| --- | --- | --- |
| **Codepoint** | **Index** | **LCID values** |
| 0 to 253 | 64 to 317 | reserved |
| 254 | 318 | Number of Desired Guard Symbols |
| 255 | 319 | Pre-emptive BSR |

NOTE 2: For the two-octet eLCID space, the 16-bit codepoint 000…00 (all zeros) corresponds to the index value of 320, while the 16-bit codepoint 111…11 (all ones) corresponds to the index value of 216+ 319.